MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2016/2017

EMG2016 – ELECTROMAGNETIC THEORY

(BE, RE, TE)

30 MAY 2017
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 7 pages excluding cover page with 4 questions only.

2. Attempt ALL 4 questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the answer booklet provided.

4. Please tear off and attach your completed Smith Chart in the answer booklet.

QUESTION 1

a) A load of $100 + j150\ \Omega$ is connected to a $75\ \Omega$ lossless line. Find the following on a Smith Chart:

i) Reflection coefficient, Γ

[4 marks]

ii) Standing wave ratio, SWR

[2 marks]

iii) The load admittance, Y_L

[3 marks]

iv) The locations of V_{max} and V_{min} with respect to the load.

[3+3 marks]

v) Z(d) at 0.4λ from the load

[5 marks]

vi) Z_{in} at the generator, if the line is 0.6λ long

[5 marks]

Continued...

QUESTION 2

a) Explain
   i) Faraday's Law
   ii) Ampere's Law
   iii) Lenz Law

[3+3+3 marks]

b) Given a sliding bar shown in Figure 2.1, find the following:

   i) If the sliding bar is fixed to create a square loop with sides of 25cm, and a time varying magnetic field $\vec{B} = \hat{z}10\cos 10^3\, t$ (T) is applied, find the V_{emf} induced.

   [6 marks]

   ii) If the sliding bar moves at a velocity of $u = \hat{y}5$ m/s, and a static magnetic field $\vec{B} = \hat{z}10$ (T) is applied, find the V_{emf} induced.

   [5 marks]

   iii) In part (ii), does the wire other than the sliding bar contribute to the V_{emf} induced? Explain.

   [2 marks]

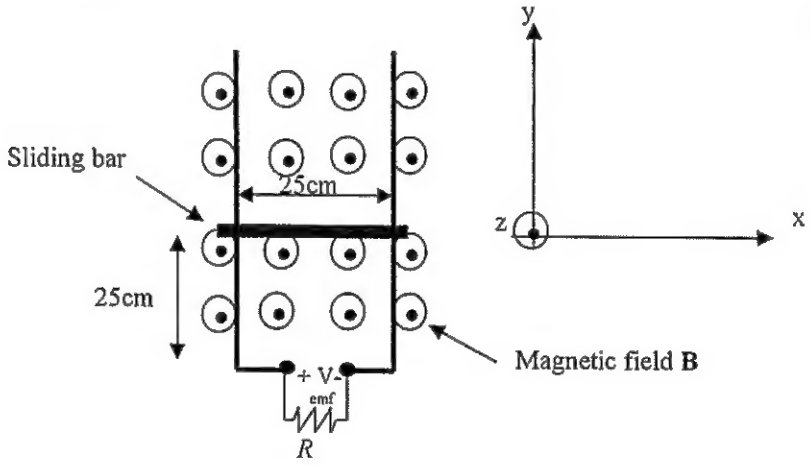

Figure 2.1

c) Calculate the displacement current on a parallel plate capacitor with plate area of $4cm^2$ and plate separation of 2mm with a voltage $10\sin(10^3t)$ V applied to its plates. Assume $\varepsilon = 2\varepsilon_o$

Hint: Displacement current density, $J_d = \frac{\varepsilon}{d} \cdot \frac{\partial V}{\partial t}$

[3 marks]

Continued...

QUESTION 3

a) Given an electric field $\overrightarrow{E^i} = \hat{y}10\cos(3 \times 10^8 t - z)$ V/m in air is incident normally on a lossless, nonmagnetic dielectric medium with $\varepsilon = 3\varepsilon_o$. Find the following:

i) The total electric field in region 1 (air)

[7 marks]

ii) The total electric field in region 2 (dielectric medium)

[6 marks]

iii) The time average power in region 1

[3 marks]

iv) The time average power in region 2

[3 marks]

b) A sinusoidal electric wave is travelling in negative y direction in a lossless medium of $\varepsilon = 3\varepsilon_o$, $\mu = 2\mu_o$. The wave is polarized in $\hat{x}$ with maximum amplitude of 10 V/m and frequency of 10 GHz. Find the expression of $\vec{E}$

[6 marks]

Continued...

QUESTION 4

a) A rectangular waveguide has dimensions a=1 cm and b=0.5 cm and is filled with a nonmagnetic medium with relative permittivity $\varepsilon_r = 9$.

i) What are the modes that can be propagated if the operating frequency is at 11 GHz?

[8 marks]

ii) What is the dominant mode? Explain.

[3 marks]

b) A rectangular air-filled resonant cavity will resonate at 12 GHz in TE_{101} mode and at 24 GHz in TE_{110} mode. If given a=2b, find the dimension of the resonant cavity.

[6 marks]

c) Describe the propagation of TEM, TE and TM waves.

[6 marks]

d) Find the propagation mode of the wave below which propagates in an air filled waveguide.

$$E_z = 10 \sin\left(\frac{2\pi}{a}x\right) sin\left(\frac{\pi}{b}y\right) \cos(20\pi \times 10^9 t - 3z)\, V/m$$

[2 marks]

Hint:

$$f_{c,mn} = \frac{1}{2\sqrt{\mu\varepsilon}}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

$$f_{r,mnp} = \frac{1}{2\sqrt{\mu\varepsilon}}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2 + \left(\frac{p}{c}\right)^2}$$

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Appendix : Physical constants

Constant	Symbol	Value
Speed of light in vacuum	c	$3x10^{8}$ m/s
Permittivity of free space	ε_o	$8.8542x10^{-12}$ F/m
Permeability of free space	μ_o	$1.2567x10^{-6}$ N/A^2
Intrinsic impedance of free space	η_o	377Ω

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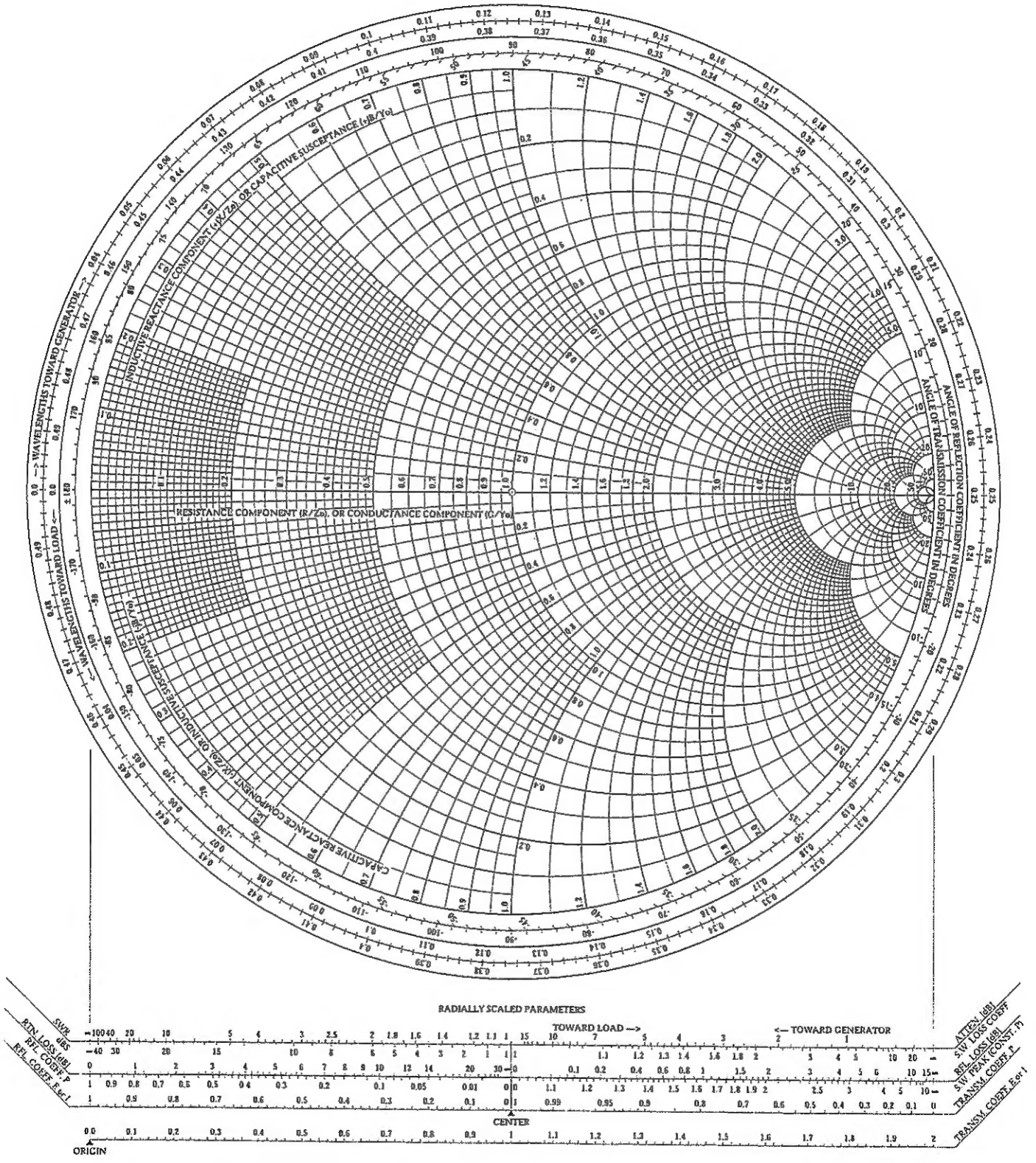
The Complete Smith Chart

Black Magic Design



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The Complete Smith Chart

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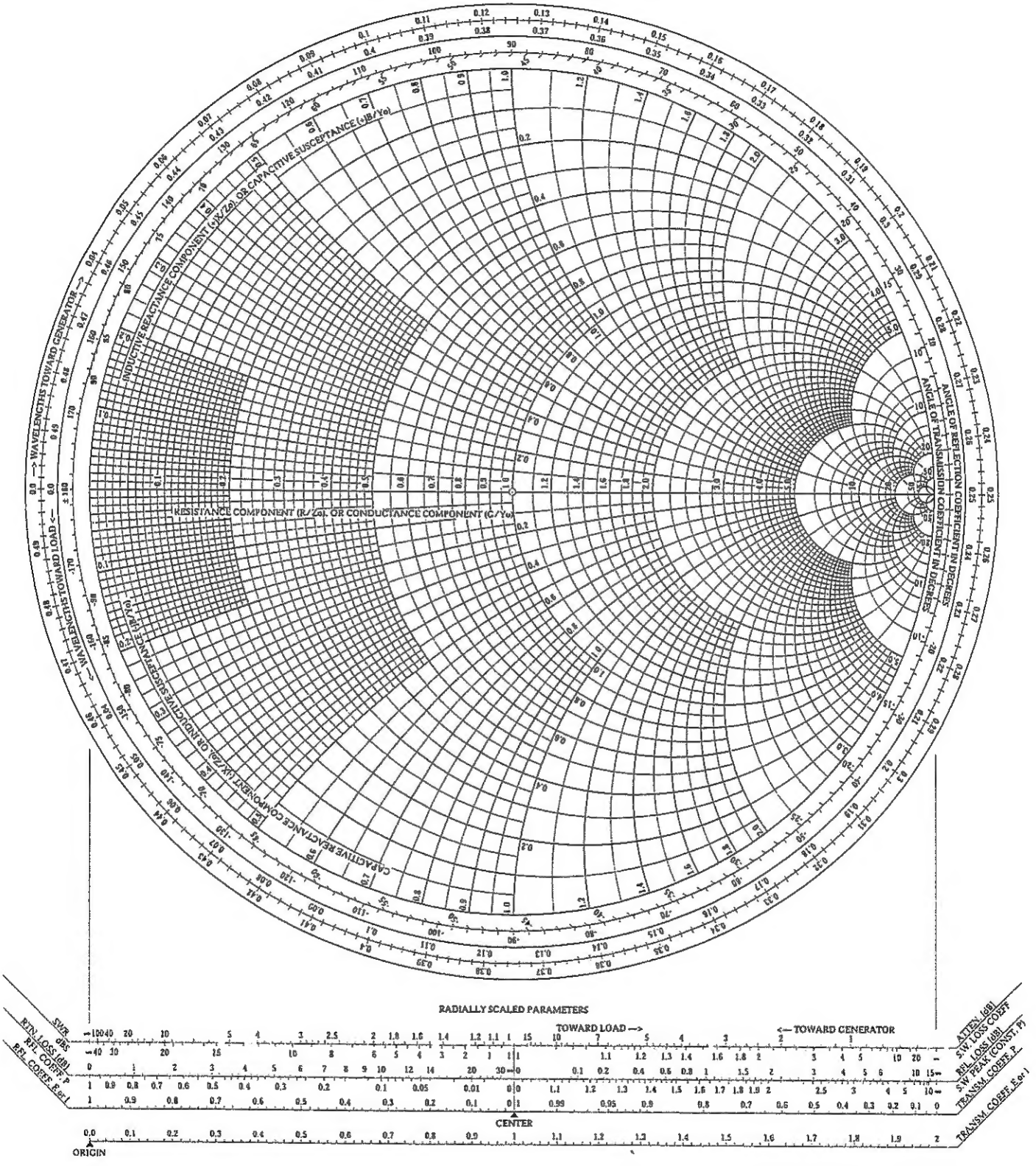

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